International Research Journal of Engineering, IT & Scientific Research
Available online at https://sloap.org/journals/index.php/irjeis/
Vol. 3 No. 5, September 2017, pages: 1~11
ISSN: 2454-2261
https://sloap.org/journals/index.php/irjeis/article/view/395

Environmental Training of Students of the Civil Engineering Career the Universidad Tecnica de Manabi

Olinda Elizabeth Caicedo Arevalo [a]
Beatriz Zumalacarregui de Cardenas [b]
Juan Manuel Labadie Suarez [c]
Maria Rodriguez Gamez [d]

Article history:

Received: 9 June 2017
Accepted: 30 August 2017
Published: 30 September 2017

Keywords:

academic program;
civil engineering;
clean energy;
environmental education;
sustainable development;

Abstract

The Civil Engineering course teaches different subjects in its academic program, which has in their educational task to offer knowledge to students, their intervention in the environmental space, within the framework of their actions as future civil engineers. The objective of the research is to reflect on the knowledge acquired in the environmental training of students of the civil engineering career. For this purpose, the standardized survey technique was used with structured questions that collected the work of the educational program of the race and was applied to 75 students of the different levels. The result obtained allowed to know to what extent the environmental training of students, has repercussions on the preparation of future civil engineers, in addition to the degree of concern for environmental problems and the predisposition to work in order to reduce the impacts derived from the professional practice of The Civil Engineering, taking into account the implication of the sustainable development in the academic formation. During the investigation, it was verified that students are aware of the importance of preservation and respect for nature through the use of clean energies, where they have expressed concern about the contamination and depletion of natural resources. The results obtained can have a positive influence on the constructive future of the province, depending on the implementation of an appropriate sustainable development policy.

Author correspondence:
Olinda Elizabeth Caicedo Arevalo,
Master Student, Civil Engineer,
Faculty of Mathematics, Physics and Chemistry, Universidad Técnica de Manabí, Portoviejo, Ecuador
Email address: *ocaicedo@utm.edu.ec*

[a] Universidad Tecnica de Manabi, Portoviejo, Manabi, Ecuador
[b] Universidad Tecnologica de La Habana, Cujae, Cuba
[c] Universidad Tecnologica de La Habana, Cujae, Cuba
[d] Universidad Tecnica de Manabi, Portoviejo, Manabi Ecuador

1. Introduction

Given the global and regional context on climate change and environmental degradation resulting from human activity and being the construction area, one of those involved in the territory that, due to the negative environmental impact that is generated in the realization of the Civil works, it becomes necessary an environmental approach in the training of the civil engineer, which must go in a parallel way both in education, as research and extension or university projection, to incorporate the ethical and aesthetic aspect of environmental training and thus avoid falling into mechanical activities lacking reflection and criticism (Molano & Herrera, 2014), a premise that in the case of Ecuador, is supported by the legal context of the Magna Carta approved in 2008, considered as a pioneer in Recognize the rights of nature, (Asamblea Constituyente, 2008) "Education will focus on the human being and ensure its holistic development, Within the framework of respect for human rights, the sustainable environment, and democracy (SENPLADES, 2015).

It is also supported by the proposals of the Ecuadorian National Planning and Development Secretariat (SENPLADES) to improve the quality of life of the population: promote the implementation of eco-city models, linked to eco-efficient infrastructure in basic services for Urban and rural settlements, located near the sea, rivers, bodies of water and agricultural sectors; And to encourage the implementation of models of territories, cities and sustainable communities for Good Living (Palacio, 2013), and in terms of compliance with Goal 7 of the National Plan for Good Living, which proposes: Ensuring the rights of nature and promoting sustainability, Environmental, territorial and global, where it is important to promote projects for the development of wastewater treatment plants, in coordination with the decentralized autonomous governments (GAD), to prevent pollution in inland waters and on the coast; All these proposals mentioned above and that have an environmental character, are part of the professional work of the civil engineer. Despite being stipulated in legal form and within a national planning, it is necessary to articulate the environmental aspect, with higher education, constituting an academic style where new paradigms are assumed in academic formation.

It is important to understand that in the academic scenario, it is necessary to articulate new forms of engineering teaching, where it is based on environmental knowledge and experiences of respect and consideration for nature; The articulation of new classrooms inserted in the task of constructive management for the environment; The training of self-directed knowledge students focused on the environmental service; The deployment of an effective learning culture, integrative and group skills training, that is integrated into the curriculum of lifelong learning, considering that the practice of engineering is global, perspective and interdisciplinary.

In the formation of Civil Engineering it is necessary to respectfully respect the appreciation of different cultures and commercial practices, ethics as a cornerstone and the deployment of communication skills (Palacio, 2013), making civil engineering students comply with a professional profile Which will make them the custodians of nature and faithful watchers of the proper use of their resources, true leaders in the discussions and decisions for the development of public environmental policies, with a multidisciplinary knowledge, highlighting principles that allow them to confront and adapt with Ease to new challenges in their professional life (Celis & Colmenares, 2016).

The humanist aspect, therefore, is considered as a characteristic of the engineer of the future, who seeks the common benefit for his fellows with a deep respect for nature, without harming the economic profits of the investor (Londoño, 2011). It is necessary to reflect on the environmental regulatory framework and its compliance as a function of the protection of nature, as well as some meanings that favor the competencies of the civil engineer in environmental matters.

It is also necessary to address other criteria that allow the evaluation of the environmental context, in order to make educational decisions, such as: the evolution of the concept of nature, which throughout the history of engineering has been taken as synonymous with natural resources, The extraction, modification and transformation of socially useful products, and under the concepts of renewable and non-renewable; That, however, at present, it has been demonstrated that the former may become non-renewable in the face of current patterns of intensive and uncontrolled exploitation.

Another criterion is that not all socially profitable products are socially useful, that it is important to assess: who, how many, and to what extent will the economic benefits of production be enjoyed, and who, how many, and how long will undesirable impacts suffer. Another aspect to consider is that of technology that, although for decades has contributed to development, hidden behind exploitation of nature and man, so we must also observe the ethical component in that sense, study the consequences of a decision, for all the sectors involved in a civil work, including the type of raw material that is required to be used or the labor to be contracted (Nieto-Caraveo, 2000).

Therefore, according to the environmental scope that must be present in the civil engineer's training, the objectives of the use of sustainability tools can be considered, both in practice and in professional and personal training, as well

as training of the capacity of analysis and valuation in the relation between economic prosperity, social equity and environmental quality (Machín *et al.,* 2012).

Given the scope of the different characteristics of the concept of nature, it implies not only the transversality of the environmental theme, understood as the diversity of transdisciplinary approaches for the same subject, but also involves crossing the boundaries between disciplines to develop new realities (Martínez Castillo, 2010).

The situation of environmental education at the higher level, is a subject widely analyzed by some authors (Sosa, 2010), who through a research to diagnose the degree of environmental culture, performed with quantitative and qualitative methods, applied to students of The Autonomous University of Campeche (Isaac-Márquez, 2011), indicates that students have a low level of environmental culture; And that in addition the institutional context does not favor education in this sense, since it is considered non-priority and therefore the spaces, infrastructure, and support for their study, teaching and promotion are not provided.

While the research carried out within the educational spectrum, they present different perceptions regarding the environmental theme, if they are complemented by a diagnosis of the students in these subjects, which can be a tool to articulate environmental education in the upper level, according to the level of knowledge and commitment in the care of the environment by the students.

2. Materials and Methods

The study area is limited to students of the Civil Engineering career of the Universidad Técnica de Manabí (UTM) With 321 enrolled; a sample size of 75 surveys was calculated with a margin of error of 6% and a confidence level of 0.95 probabilities that the obtained results were valid, for the calculation of the sample size, equation 1.

$$\mathbf{n} = \frac{(\boldsymbol{Z^2})(\boldsymbol{P})(\boldsymbol{Q})(\boldsymbol{N})}{(\boldsymbol{Z})^2\,(\boldsymbol{P})(\boldsymbol{Q})+(\boldsymbol{ne})^2} \qquad (1)$$

Where:
n→ Sample Size Required
Z → Reliability level (with a 95% security the standard value of 1.96 is used)
N→ Size of the population (321 students of the first level of Civil Engineering)
p→ Positive variability (0.5)
q→ Negative variability (0.5)
e→ Error range (6%)

The instrument is an adaptation of the questionnaire used by the "Recerca Educació i Ciutadania (GREIC) de la Universitat de les Illes Balears", Arising from research: Training European Teachers for Sustainable Development and Intercultural Sensitivity (TETSDAIS) (Oliver, 2005), Arranged in two groups, the first identifies knowledge about various environmental aspects and the second group deals with the main causes of environmental problems and their predisposition to pay for environmental services. Surveys were analyzed and descriptive statistics were applied, with the use of central tendency and frequencies to reach the proposed objectives; classified as non-experimental because the variables cannot be manipulated.

3. Results and Discussions

From the revision made in the official documents, it was verified that the civil engineering career is one where there is more enrollment of students by the different levels. In figure 1 it can be observed graphically that although in 2017 the enrollment was of 321 students, the number of students from the third level decreases notably to less than half, with a slight increase in the tenth level. This implies an unfavorable behavior of academic retention in previous years

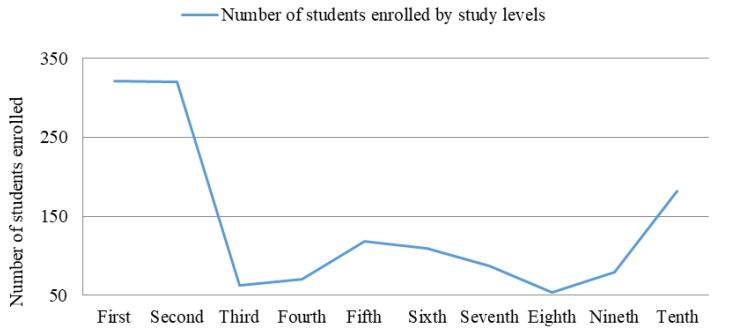

Figure 1. The behavior of the number of students per level

It was investigated the content of the academic program of the students of the race and it was verified that in the 60 subjects are distributed, distributed in 10 levels, that is to say, 6 in each level, being able to verify that in all the cases they do not incorporate environmental subjects.

It was verified that of the ten levels of the race only in six of them they include environmental subjects within the program of the basic subjects, these are: in the first level civil engineering and general chemistry; second level, drawing and introduction to research; third level, education in values and citizen rights; fourth level: socioeconomic, cultural and ecological reality of Ecuador, ninth level sewerage and water treatment and project design and evaluation; and in the tenth level organization of works. There are four levels that do not receive themes from the environmental area. Figure 2 shows graphically the behavior by levels of the subjects that are taught and of them that include environmental subjects

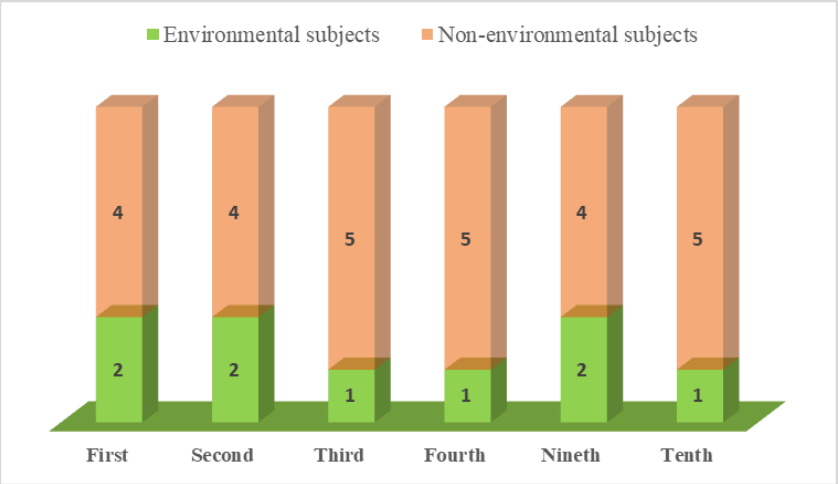

Figure 2. Number of subjects with environmental themes

Surveys were analyzed and descriptive statistics were applied with the use of central tendency and frequencies to reach the proposed objectives; classified as non-experimental because the variables cannot be manipulated. As for the first question that refers to the definition that one has when mentioning nature, the options plants and related problems get 40%; while the animal's option obtains 13% and; the concept option 7%.

The second question related to the definition when it mentions the environment, the option related problems gets 47%; The option plants 43%; The option 7% and animals; The option concept 3%. Figure 3 shows the results of the two questions discussed above.

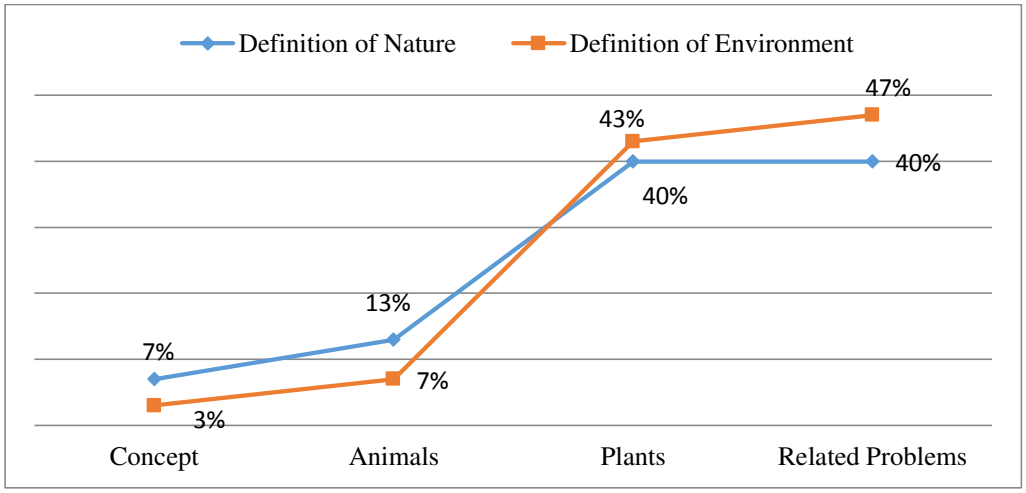

Figure 3. Mastery of environmental concepts by students

It is important to emphasize the importance of the clarity of concepts in the behavior of people as a function of environmental protection. The concept can be defined as a cognitive unit of meaning. Their formation is closely linked to a context of the experience of reality itself; Of individual, cultural, social, etc. experience. Its construction arises through the integration of classes or cognitive experiences, which group new knowledge and new experiences with the knowledge and experiences stored in memory.

It is very difficult for a person with poor conceptual knowledge to develop a favorable state of consciousness in the interest of environmental advocacy. The results of the survey allowed us to define what the students surveyed did not have an adequate conceptual domain of the definitions related to nature and the environment and this could negatively influence the understanding of the role that each one should play as a professional, and even As a human being before the protection of the environment.

This is a situation that should be taken into consideration by career managers, in order to redouble efforts to reverse the students' lack of knowledge about environmental concepts.

Question three is related to the environmental problem that most affects your life. In this sense, 50% of the students identified the destruction of green areas; Water pollution by 37%; 10% global warming and; 3% waste generation. Figure 4 shows the graphical behavior of the opinions expressed by the students surveyed

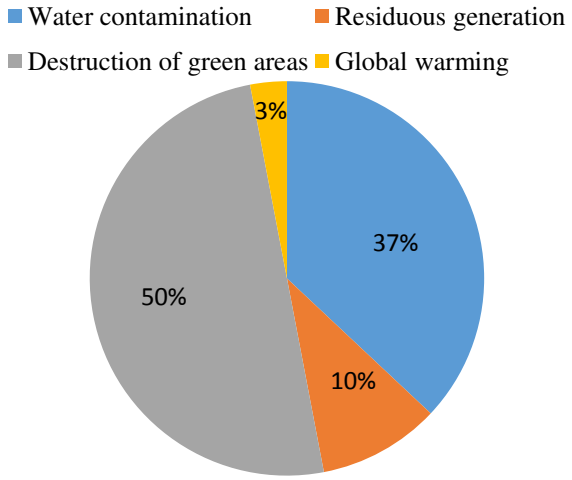

Figure 4. Environmental problems that most affect your life

It is significant to highlight that the students were able to identify the main environmental problems that are associated with the life of the society in the territory, however, others were not visualized that are closely related to the professional practice of Civil Engineering, such as The depletion of natural resources; The affectations to the landscape and; Air pollution among others. This may be due to the poor environmental preparation received by students.

Related to question four that deals with the degree of concern about environmental problems according to geographic level, students surveyed expressed the greatest concern at planetary level with 87%; In terms of country-level 67%; at regional level 40% y; at the local level 27%. Figure 5 shows the graphical behavior of the opinions offered by the students.

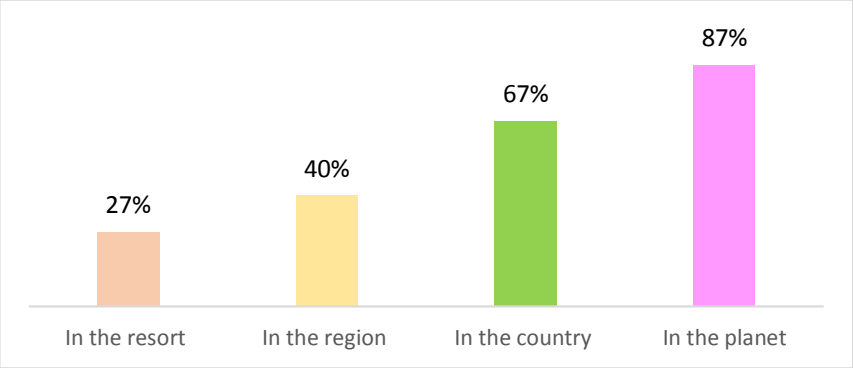

Figure 5. The degree of concern about environmental problems according to geographic level

The environmental impacts that affect the planet are the sum of environmental problems that occur at the local, national and regional level, however, the greatest concern of the students surveyed is manifested by the higher level, where individual action to protect the planet Environment can be symbolic. When environmental risk is appreciated at the local level, knowledge can be better applied to reduce these impacts by implementing programs and strategies aimed at improving conditions at the national, regional and local levels planet. It is at the local level where the university can exert the greatest influence.

The research developed allowed us to know what happened at the level of the country in terms of the issues that today are in environmental risks, here analyzed the seriousness of the environmental problems at the country level, only took into account the response of the column Very serious, in Where students selected pollution from rivers, lakes, and reservoirs as the most serious environmental problem with 80%; Followed by environmental pollution, pollution of seas and beaches, as well as industrial waste with 77%; Forest fires with 73%; Untreated wastewater 60%; Little interest in the conservation of nature and species with 50% and; In the option Other: they indicated smog and exploitation of natural resources with 7%. Figure 6 shows the results.

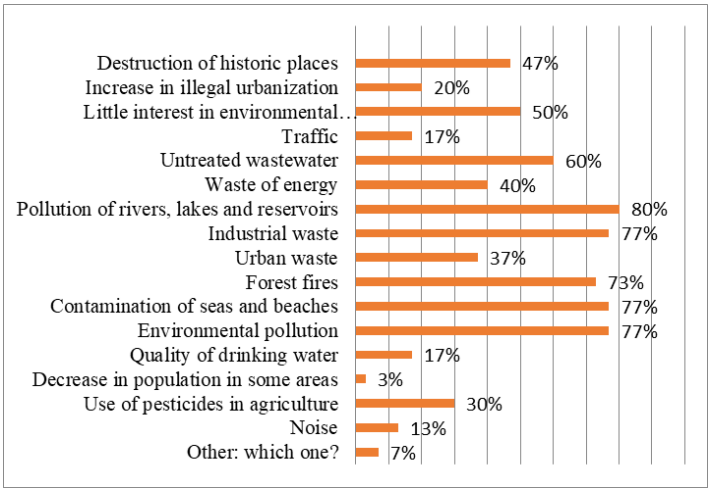

Figure 6. The severity of environmental problems at the country level

The survey allowed verifying that the students surveyed were able to identify the main environmental problems that affect the country level, being a positive element that can facilitate the action of the same ones, in function of working to reduce the impacts generated in the professional practice of Engineering Civil.

Water is one of the basic elements for the development of a society and is among the activities that the students have identified as the greatest risks at the country level, investigating what were the factors that affected water pollution, It is possible to identify that one of the causes that most affected was industrial waste, the lack of penalties and fines for those who pollute, sewage in poor condition, lack of legal action, use of pesticides, these results are shown in figure 7

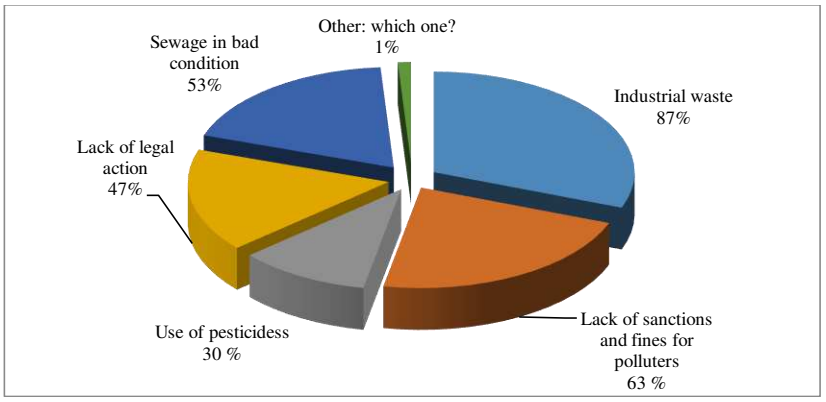

Figure 7. Main causes of water pollution

Related to question seven that addresses the main causes of pollution by waste, students raised as the main cause the lack of active cooperation of citizens with 93%; The lack of national and municipal planning for waste treatment with 67%; Lack of corporate responsibility with 60%; Lack of action of the municipalities with 50% and; The lack of respect of people with 33%. Figure 8 shows the graphical results on the behavior of the main causes of the contamination of residues

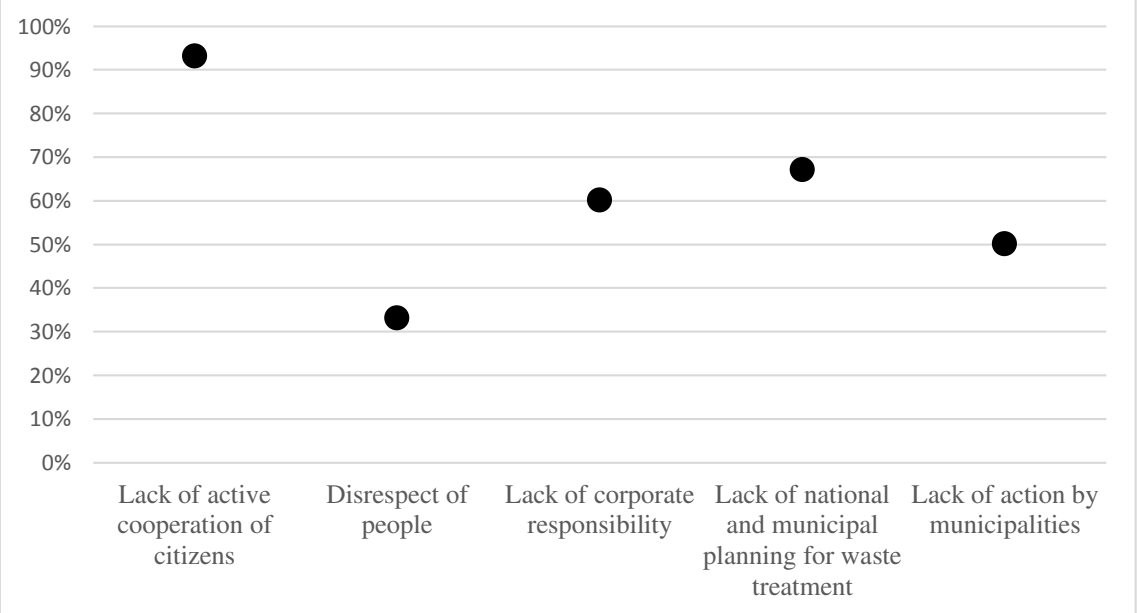

Figure 8. The behavior of the main causes of waste pollution

The results of the survey in the question related to the contamination by residues, is a sample of the academic effectiveness, when subjects related to the environmental protection are imparted, since the students have been able to

identify properly the main causes that cause the contamination by residues, Where the lack of cooperation of the citizens, the lack of responsibility of the companies and the lack of willingness of the municipal authorities to put in practice measures aimed at obtaining an adequate treatment of the residuals, so that they do not derive as an environmental contamination .

Regarding question eight that deals with the energy sources in which the country should invest, the students pointed to the solar energy and the hydroelectric, both with 77%; Wind with 43%; Oil with 40%; Tide with the (33%); Nuclear with 13%; The gas with 10% and; Coal with 3%. Figure 9 shows the graphical behavior on the criterion of the students according to the energy sources where the country should invest.

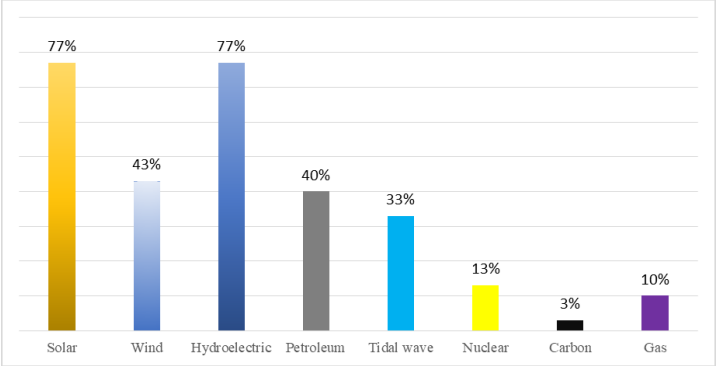

Figure 9. Energy sources in which the country should invest

It was verified that in the academic program the students receive information on the renewable sources of energy and their advantages in relation to the conventional sources, in order to reduce the impacts to the environment, where the students were able to identify the energy sources that can be implemented according to the Resources. Nonetheless, there is a need to continue deepening in this regard, as there are some that have indicated as sources for investment in oil, nuclear and coal, which correspond to those that pollute the most and are in fact responsible for the current state of environmental Exists, especially oil.

In question nine where the predisposition to pay for environmental services was analyzed, students responded with the highest score of paying more taxes if it were known that the money would be used to protect the environment with 60%; The option of paying higher prices so that commercial companies can better preserve the environment with 57% and; The option to pay if there were product brands that were respectful with the environment with 37%. Figure 10 shows the graphical behavior on the predisposition to pay for environmental services.

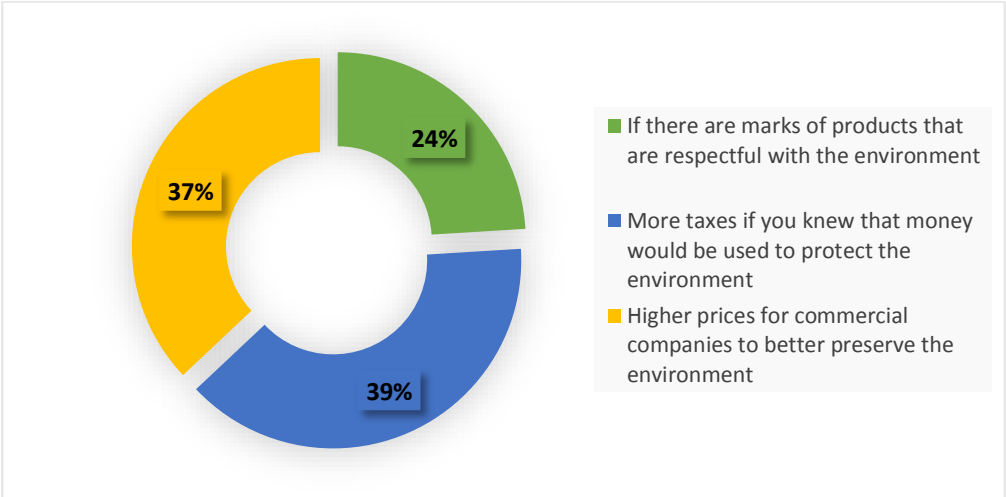

Figure 10. Predisposition to pay for environmental services

It was verified that the students are able to identify the economic incentives that can be applied, to promote the fulfillment of the environmental services

4. Conclusion

The development of the research showed that, at the fifth, sixth, seventh and eighth levels, students of the Civil Engineering career of the UTM do not receive any material related to environmental training, which may influence a weak preparation of The professionals graduated from this career. In the same way, it was verified that the students of the Civil Engineering career of the UTM, are not receiving training in some environmental issues that should be incorporated in the *pensum* of the race. At the same time, it was verified that the majority of the students are sensitized with the current environmental situation, being able to apply the academic knowledge acquired in the exercise of their professional duties once they have graduated from their university studies.

Conflict of interest statement and funding sources

The author(s) declared that (s)he/they have no competing interest. The study was financed by the UTM.

Statement of authorship

The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

Acknowledgments

Special thanks are given to the administration of the Universidad Técnica de Manabí for their support to carry out this research.

References

Caicedo Arévalo, O. E. (2018). *Gestión ambiental en la carrera de Ingeniería Civil de la Universidad Técnica de Manabí* (Doctoral dissertation, Universidad Tecnológica de La Habana: José Antonio Echeverría).

Castillo, R. M. (2010). La importancia de la educación ambiental ante la problemática actual. *Revista Electrónica Educare*, *14*(1), 97-111.

Celis, J., & Colmenares, J. E. (2016). Hacia una formación más fundamentada y flexible en ingeniería civil. *Revista Educación en Ingeniería*, *11*(21), 4-8.

Constituyente, A. (2008). Constitución de la República del Ecuador.[online] Available at:< http://www. asambleanacional. gov. ec/documentos. *Constitucion-2008. pdf>[Accessed August 1st 2012]*.

Isaac-Márquez, R., García, S., Orlando, O., Eastmond Spencer, A., Arcipreste, A., Esther, M., ... & Manzanero Acevedo, L. A. (2011). Cultura ambiental en estudiantes de bachillerato: Estudio de caso de la educación ambiental en el nivel medio superior de Campeche. *Revista electrónica de investigación educativa*, *13*(2), 83-99.

Londoño, R. D. (2011). Aportes y perspectivas de la ingeniería en el desarrollo humano en Colombia, en el devenir de los últimos 200 años. *Revista Epsilon*, (16), 11-30.

Machín, F., García, M., Rodríguez, F., & Roverón, A. (2012). La sostenibilidad como enfoque para la formación de los ingenieros en el siglo XXI. Pedagogía Universitaria, XVII (2), 79-80.

Molano Niño, A. C., & Herrera Romero, J. F. (2014). La formación ambiental en la educación superior: una revisión necesaria. *Revista Luna Azul*, (39).

Nieto Caraveo, L. M. (2000). Ideas básicas para la formación de profesionales de la ingeniería ante los desafíos de la problemática ambiental. In *Ideas básicas para la formación de profesionales de la Ingeniería ante los desafíos de la problemática ambiental*. ANEA.

Oliver, M. C., Keast-Butler, O. D., Hinves, B. L., & Shepperd, J. A. N. (2005). A hydroxyapatite-coated Insall-Burstein II total knee replacement: 11-year results. *The Journal of bone and joint surgery. British volume*, *87*(4), 478-482.

SENPLADES, S. (2015). Agenda Zonal, Zona 4-Pacífico (Primera). Quito, Ecuador: Secretaría Nacional de Planificación y Desarrollo-SENPLADES.

Sosa, S. B., Isaac-Márquez, R., Eastmond, A., Ayala, M. E., & Arteaga, M. A. (2010). Educación superior y cultura ambiental en el sureste de México. *Universidad y ciencia*, *26*(1), 33-49.

Biography of Authors

Civil Engineer, Bachelor in Education Sciences. Master in Education and Social Development. Teacher of the Faculty of Philosophy, Letters, and Sciences of the Education and professor of the Faculty of Mathematical Sciences, Physics and Chemistry of the Universidad Técnica de Manabí. Ecuador
Email: ocaicedo@utm.edu.ec

She holds a degree in Chemistry, a Ph.D. in Chemical Sciences, a full professor, a consultant professor and head of the Department of Chemical and Biological Foundations of the Faculty of Chemical Engineering of the José Antonio Echeverría Higher Polytechnic Institute, Cujae. Vicedecana in the Faculty of Chemical Engineering. Cujae. Dean of the Faculty of Chemical Engineering and member of the Technical Evaluation Committee of the National Accreditation Board and of the Board of Directors of the Cuban Chemical Society

Chemical Engineer, Specialist in Wastewater Treatment and Environmental Engineering. Professor of the Faculty of Chemical Engineering, Cujae since 1975, President of the Pan American Committee for Environment and Human Development - UPADI, Cuba. President of the Society of Geosciences UNAICC and Member of the Environment Committee of MICONS – Cuba

Doctor in Science, professor of the Faculty of Mathematical, Physical and Chemical Sciences, the Universidad Técnica de Manabí, with several scientific publications participation in international congresses. Works on research projects on sustainable local development, renewable sources.